

A17 Sub 0.1 > 4. (Amended) A tripod constant velocity universal joint as set forth in Claim 1, wherein a ratio L_s/d_o of the width (L_s) to an outer diameter (d_o) of said roller is 0.32 or below.

Sub 0.1 > 6. (Amended) A tripod constant velocity universal joint as set forth in Claim 1, wherein a portion of said roller guide surface corresponding to the end of said roller is formed with a relief portion.

A18 7. (Amended) A tripod constant velocity universal joint as set forth in Claim 6, wherein said relief portion is an arc smoothly connected to said roller guide surface.

REMARKS

Claims 1-23 are pending. Claims 8-23 have been withdrawn from consideration by the Examiner for being drawn to a non-elected species. By this Amendment, the Specification and Claims 1-2, 4, and 6-7 are amended. No new matter is presented.

Drawings

The drawings are objected to under 37 CFR 1.84(h)(5) because Figure 4 shows a modified form of construction in the same view. Enclosed herein is a Request for Approval of Drawing Corrections along with Figures 4A and 4B, which replace originally filed Figure 4 and are responsive to the objection. Applicants respectfully submit that the Specification is amended to correspond with drawing Figures 4A and 4B.

Withdrawal of the objection is respectfully requested.

The drawings are objected to under 37 CFR 1.84(p)(5) because reference characters r , T , and θ appear in Figures 5A and 5B, but are not mentioned in the specification. Applicants provide the following comments to the objection.

Regarding reference character *r* in Figure 1, the enclosed Request for Approval of Drawing Corrections deletes reference character *r* therefrom to be responsive to the objection.

With regards to reference character *r* in Figures 5A and 5B, the Specification is amended herein to clarify that reference character *r* identifies the radius of curvature of the outer peripheral surface of the roller 30.

Regarding reference character *T*, Applicants respectfully submit that the reference character represents the applied predetermined torque and have amended the Specification to clarify such.

Regarding theta (θ), Applicants respectfully note that theta represents the skew angle as explained on the first and second full paragraphs of page 4 of the specification and further on pages 26-29.

Withdrawal of the objection is respectfully requested.

The drawings are objected to under 37 CFR 1.84(p)(5) because reference character *R* appears in Figures 1, 5A and 5B. Applicants respectfully submit that reference character *R* identifies the radius of curvature of the roller guide surface 14 and have amended the Specification to remove any inconsistencies related thereto.

Withdrawal of the objection is respectfully requested.

The Office Action requires that Figures 5A and 5B be identified by a legend, such as, Prior Art. The enclosed Request for Approval of Drawing Corrections amends Figures 4A, 5A and 5B to have a --Related Art-- legend.

Withdrawal of the objection is respectfully requested.

Specification

The Abstract of the Disclosure is objected to for including improper content. Enclosed herein is a Substitute Abstract that is responsive to the

objection.

Withdrawal of the objection is respectfully requested.

The Specification is objected to because the disclosure does not provide the dimensions that define the term "contact ratio," which appears throughout the specification and claims 1-7 of the application. Applicants respectfully traverse the objection.

Applicants respectfully submit that the term "contact ratio" is dimensionless because features of having the same dimensions are being compared to each other. Specifically, "contact ratio" defines the ratio of the radius of curvature R of the roller guide surface to the radius of curvature r of the roller outer peripheral surface. The Specification has been amended to clarify such.

Withdrawal of the objection is respectfully requested.

The disclosure is objected to because page 4 of the Specification contains an undefined acronym "NVH." The Specification has been amended to clarify the definition of the acronym, in particular, that NVH is the well known acronym for "noise, vibration, hardness."

Withdrawal of the objection is respectfully requested.

The disclosure is objected to because page 10, lines 7-8 incorporates essential material from a publication by reference, which is improper. The Specification has been amended responsive to the objection.

Withdrawal of the objection is respectfully requested.

The Specification is objected to because the detailed description does not provide proper antecedent basis for the feature "contact ellipse . . . does not deviate from the end surface of said roller" recited in claim 1, lines 13-16. Applicants respectfully traverse the objection. In particular, Applicants

respectfully submit that the paragraph bridging pages 12 and 13 of the Specification provides antecedent basis for the recited feature in question.

Withdrawal of the objection is respectfully requested.

The specification is objected to because the detailed description does not provide proper antecedent basis for the feature "contact surface pressure produced on said roller" recited in claim 1, lines 13-16. Applicants respectfully traverse the objection. In particular, Applicants respectfully submit that the first full paragraph on page 8 of the specification provides antecedent basis for the recited feature in question.

Withdrawal of the objection is respectfully requested.

Formal Matters Regarding the Claims

The claims are objected to because the features of the claims are not separated by indentation. The claims have been amended responsive to the objection.

Withdrawal of the objection is respectfully requested.

Claims Recite Patentable Subject Matter (Part I)

Claims 1-7 are rejected under 35 U.S.C. § 112, first paragraph. Applicants respectfully traverse the rejection.

With regards to claims 1 and 3, the Office Action notes that the recited feature of the "contact ratio is 1.01 or above," but the Specification does not describe the dimensions that define the ratio. Accordingly, the Office Action argues that undue experimentation would be required to make and/or use the claimed invention because it would take undue experimentation to determine the dimensions that define the "contact ratio."

With regards to claim 2, the Office Action Examiner alleges the only way to accomplish the recited feature of the surface pressure on the rollers being set

so as not to exceed the surface pressure between the trunnion and needles is by making the contact ratio with a certain range. However, because the manner for making the contact ratio with a certain range is not enabled (for the reasons discussed above), the Office Action argues that the feature recited by claim 2 is not enabled.

As explained above, the term "contact ratio" is dimensionless because features having the same dimensions are being compared to each other. Specifically, "contact ratio" defines the ratio of the radius of curvature R of the roller guide surface to the radius of curvature r of the roller outer peripheral surface. Accordingly, Applicants respectfully submit that undue experimentation would not be necessary because one of ordinary skill in the art would understand that the ratio is dimensionless as features having the same dimensions are being compared to each other, wherein the dimensions cancel each other out. Furthermore, Applicants respectfully submit that as a result of the contact ratio being dimensionless, and because one of ordinary skill in the art would not have to perform undue experimentation to arrive at the recited feature, the claims recite features that would enable one of ordinary skill in the art to which the invention pertains to make and/or use the claimed invention.

Withdrawal of the rejection is respectfully requested.

Claims 1-7 are rejected under 35 U.S.C. § 112, second paragraph. Applicants respectfully traverse the rejection.

The Office Action states the feature of the "contact ratio" is recited on claims 11-12 of claim 1, but the dimensions that define the ratio are not described in the specification and it is not possible to determine the "contact ratio" for a given universal joint. As discussed above, the term "contact ratio" to be dimensionless because features having the same dimensions are being

compared to each other. Specifically, "contact ratio" define the ratio of the curvature R of the roller guide surface to the radius of curvature r of the roller outer peripheral surface. Accordingly, Applicants respectfully submit that the claim is not indefinite and that one of ordinary skill in the art would understand the ratio is dimensionless as features having the same dimensions are being compared to each other, wherein the dimensions cancel each other out.

The Office Action also states lines 13-14 of claim 1 recite the feature of "the contact ellipse produced in said roller," however, the only "contact ellipse" disclosed is at least partially external to the roller 30. Therefore, the Office Action states that it is not clear what constitutes the "contact ellipse" that is "in" the roller. Applicants respectfully submit that the first full paragraph on page 8 of the specification provides an explanation of the recited feature in question.

The Office Action notes that lines 13-16 of claim 1 recite the feature of "the contact ellipse . . . does not deviate from the end surface of said roller." However, the Office Action states it is not clear how the "contact ellipse" would deviate from the end surface of the roller. Applicants respectfully submit that the paragraph bridging pages 12 and 13 of the Specification provides a detailed explanation of how the ellipse would deviate from the end of the roller. Specifically, if the contact ratio becomes too small and the width of the resulting contact ellipse becomes correspondingly large, the width of the contact ellipse exceeds the width of the roller, hence "deviating" from the roller.

Withdrawal of the rejection is respectfully requested.

Claims Recite Patentable Subject Matter (Part II)

Claims 1-7 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,376,050 to Krude et al. (hereinafter "Krude"). Applicants respectfully traverse the rejection.

Pending claim 1 recites a tripod constant velocity universal joint including an outer joint member having three axial track grooves in an inner periphery and roller guide surfaces formed in opposing side walls of each track groove. A tripod member has three radially projecting trunnion journals. Rollers rotate around respective trunnion journals through a plurality of needle rollers and are received in the track grooves of the outer joint member. Each roller is guided on an outer peripheral surface by the roller guide surfaces. Contact between the roller and roller guide surfaces is circular and has a contact ratio that is 1.01 or above and a width dimension of the roller is reduced to the extent that a contact ellipse produced by the roller during application of a predetermined torque does not deviate from an end surface of the roller. The contact ratio is defined by a widthwise length of the contact ellipse formed by the roller contacting the guide surface relative to the width of the roller.

The Office Action states that Figure 1 of Krude shows a tripod joint including all the features of the claims but does not expressly disclose contact ratio in the range of 1.02 to 1.2. However, the Office Action argues that it would have been obvious to one of ordinary skill in the art to have the contact ratio substantially between 1.02 and 1.2, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. See In re Killing, 895 F.2d 1147, 14 USPQ2d 1056.

Applicants respectfully agree with the Office Action regarding the fact that Krude lacks any disclosure regarding the contact ratio being within the claimed range. Furthermore, Applicants acknowledge the Office Action correctly states the current status of U.S. patent law with regards to claimed ranges in that where general conditions of a claim are disclosed in the prior art,

it is not deemed inventive to discover the optimum or workable ranges. However, Applicants respectfully direct the attention of the Office to M.P.E.P. § 2144.05 Article III which clearly states that such rejections can be overcome by showing the criticality of the claimed range. In other words, the Applicants must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range.

Applicants respectfully submit that they explain the problems inherent in the related art where the range of the contact ratio is 1.002-1.008. See the paragraph bridging pages 2-3 through the paragraph bridging pages 3-4. Specifically, the cited passage of the application explains that in the case of circular contact by the conventional tripod constant velocity universal joint, since the contact ratio ranges from 1.002 to 1.008 when a predetermined torque is applied, the widthwise contact ellipse length some times exceeds the width of the roller. For this reason, there is a limit to how much the width of the roller can be reduced.

The Applicants further explain that if the width of the roller is reduced, the total widthwise contact length far exceeds the width of the roller, thereby limiting the overall life of the tripod joint and limiting the amount the vibration can be reduced.

The Applicants further explain that the roller guide surfaces of the conventional tripod joint have a radius of curvature at a certain contact ratio and the major and minor inner diameters are, as such, connected. When the conventional tripod joint is rotating, angular displacement occurs between the roller and the roller guide surfaces, which causes the roller guide surface to wear prematurely. Consequently, the roller cuts into the roller guide surfaces, which directly results in increased vibration.

Accordingly, Applicants respectfully submit they have recognized that by ensuring the form of contact between the roller and the roller guide surfaces is circular, and the contact ratio is set to be 1.01 or higher, the widthwise contact ellipse length under a predetermined torque load does not exceed the widthwise length of the roller. Accordingly, the stated criticality of the recited range is the unexpected results that are derived therefrom. Specifically, the above described drawbacks in the related art are overcome, the weight of the tripod joint is reduced, the overall size of the tripod joint is more compact, and the tripod joint is made to be more durable than the conventional tripod joint.

As such, Applicants respectfully submit that the subject matter recited by pending claim 1 is not obvious in view of the disclosure of Krude and the statements relating thereto made in the Office Action. Accordingly, Applicants respectfully submit that pending claim 1 is not obvious in view of the Krude disclosure and should be deemed allowable.

Claims 2-7 depend from claim 1. It is respectfully submitted that these six (6) dependent claims should be deemed allowable for at least the same reasons as claims 1, as well as for the additional subject matter recited therein.

Withdrawal of the rejection is respectfully requested.

Conclusion

In view of the foregoing, reconsideration of the application, withdrawal of the outstanding objections and rejections, allowance of claims 1-7, and the prompt issuance of a Notice of Allowability are respectfully solicited.

Should the Examiner believe anything further is desirable in order to place this application in better condition for allowance, the Examiner is requested to contact the undersigned at the telephone number listed below.

In the event this paper is not considered to be timely filed, the Applicants respectfully petition for an appropriate extension of time. Any fees for such an extension, together with any additional fees that may be due with respect to this paper, may be charged to counsel's Deposit Account No. 01-2300, **referencing docket number 100725-00040.**

Respectfully submitted,

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Enclosures: Substitute Abstract
 Request for Approval of Drawing Corrections
 Amended Figures 1, 4A, 4B, 5A, and 5B
 Marked Up Version of Specification as Amended
 Marked Up Version of Claims as amended

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Marked Up Version of Specification as Amended

IN THE SPECIFICATION:

Please amend the Specification as follows:

Please amend the second full paragraph on page 2 as follows:

A conventional tripod constant velocity universal joint, as shown in the [left half of] Fig. 4A [4], comprises an outer joint member 10' having three axial track grooves 12' in the inner periphery thereof and formed with roller guide surfaces 14' in the opposed side walls of each track groove 12', a tripod member 20' having a trunnion barrel [21] 21' adapted to be fitted to a shaft for torque transmission and trunnion journals 22' radially projecting from three circumferentially equispaced positions on the trunnion barrel 21', and rollers 30' each rotatable around the trunnion journal 22' through a plurality of needle rollers 32' and received in the track grooves 12' of the outer joint member 10', the roller 30' being guided in the outer peripheral surface by the roller guide surfaces 14'.

Please amend the second full paragraph on page 2 as follows:

In the case of angular contact, when a contact ellipse is produced at two points in the direction of the contact angle and a predetermined torque Γ is applied, it is necessary that the contact ellipse be in the width of the roller 30'. For this reason, in the existing circumstance, the proportion of the width of the roller 30' to the outer diameter ranges from 32% to 36%. Further, even if the contact angle and contact ratio are reconsidered, the total widthwise contact length exceeds the width of the roller 30'. The phenomenon of both ends of the roller 30' cutting into the roller guide surfaces 14' or the phenomenon of two contact ellipses overlapping each other in the middle of the roller 30', which has been an obstacle to improvement of life and to the reduction of vibration, cannot

be avoided.

Please amend the paragraph bridging pages 2 and 3 as follows:

In the case of conventional circular contact, since the contact ratio ranges from 1.002 to 1.008 when a predetermined torque T is applied, the widthwise contact ellipse length some times exceeds the width of the roller 30'. For this reason, there is a limit to the reduction of the width of the roller 30' as in the case of angular contact. In the existing circumstances, the proportion of the width of the roller 30' to the outer diameter ranges from 32% to 36%. Further, if the width of the roller 30' is reduced, the total widthwise contact length far exceeds the width of the roller 30', obstructing the improvement of life and the reduction of vibration.

Please amend the first full paragraph on page 3 as follows:

Further, in both angular contact and circular contact, the roller guide surfaces 14' have a radius of curvature R at a certain contact ratio and the major and minor inner diameters are, as such, connected [at R (without relief)]. When the tripod joint is rotating while taking an operating angle, an angular displacement also occurs between the roller 30' and the roller guide surfaces 14'. This causes wearing of the roller guide surfaces to proceed. Then, there occurs on both the major and minor diameter sides the phenomenon of both ends of the roller 30' cutting into the roller guide surfaces 14', forming a cause of increasing the vibration.

Please amend the second full paragraph on page 4 as follows:

It has been found that the [NVH] noise, vibration, hardness (hereinafter "NVH") characteristic of tripod joints depends on the angle at which needle rollers can actually skew. The skew angle is determined by the radial clearance and circumferential clearance but this has not heretofore been taken

into consideration. Therefore, the NVH characteristic differs according to differences in the proportions or size of a tripod joint and optimization of this situation has not been made at present.

Please amend the paragraph bridging pages 7 and 8 as follows:

According to an embodiment of the invention, a tripod type constant velocity universal joint comprises an outer joint member having three axial track grooves in the inner periphery and roller guide surfaces formed in the opposed side walls of each track groove, a tripod member having three radially projecting trunnion journals, and rollers rotatable around the respective trunnion journals through a plurality of needle rollers and received in the track grooves of the outer joint member, each roller being guided in the outer peripheral surface by the roller guide surfaces, wherein contact between the roller and the roller guide surfaces is circular contact whose contact ratio is 1.01 or above and the width dimension of the roller is reduced to the extent that the contact ellipse produced in the roller during the application of a predetermined torque does not deviate from the end surface of the roller. In other words, as will become clear from the following discussion, the contact ratio defines the ratio of the radius of curvature R of the roller guide surface relative to the radius of curvature r of the roller outer peripheral surface. By ensuring that the form of contact between the roller and the roller guide surfaces is circular contact and setting the contact ratio such that the widthwise contact ellipse length under a predetermined torque load is not more than the widthwise length of the roller, it is made possible to achieve weight reduction, compactification and good durability.

Please amend the first full paragraph on page 8 as follows:

The contact ratio of the roller to the roller guide surface may be so set that the surface contact pressure produced [on] by the roller during the

application of a predetermined torque is not more than the contact surface pressure produced between the trunnion journal and the needle rollers. In particular, the contact ratio of the roller to the roller guide surface may range from 1.02 to 1.2.

Please amend the paragraph bridging pages 8 and 9 as follows:

The portion of the roller guide surface corresponding to the end of the roller may be formed with a relief portion. The provision of such relief portion prevents the roller from cutting into the roller guide surfaces and makes it possible to obtain good vibration characteristics. Since the corner [R] portion (which is a cold forged surface, thus having no edge) which connects the radius of curvature, R, of the roller guide surfaces to the relief portion makes contact within the range of the roller outer diameter [R] surface, no cutting-in occurs. Preferably, the relief portion may be in the form of an arc smoothly connected to the roller guide surface.

Please amend the first full paragraph on page 10 as follows:

These skew angles θ_1 and θ_2 are obtained and the smaller one is the skew angle that can actually occur [(refer to "BEARINGS" BY Norimune Soda, published by Iwanami Shoten, Publishers)].

Please amend the fourth full paragraph on page 17 as follows:

The roots of the [the] trunnion barrel and the trunnion journal may be of two-step shape, and the corner at the trunnion journal may be one [R] surface, or a round surface, continuously extending with a predetermined radius of curvature.

Please amend the fifth full paragraph on page 18 as follows:

Fig. [4] 4A shows a cross sectional [views] view of a conventional tripod [joints, with an embodiment of the invention and a conventional example shown

side by side for comparison] joint;

Please insert the following paragraph between the fifth and sixth full paragraphs on page 17 as follows:

Fig. 4B shows a cross sectional view of the tripod joint according to an embodiment of the present invention;

Please amend the first full paragraph on page 24 as follows:

As has been described, in the first embodiment of the invention, the form of contact between the roller and the roller guide surfaces is circular contact and the contact ratio is set so that the widthwise contact ellipse length is not more than the widthwise length of the roller during the application of a predetermined torque, whereby weight reduction, compactification and good durability of the tripod joint can be achieved. Fig. [4] 4B illustrates this. In Fig. 4A [the same figure], a conventional tripod joint is shown in the left half and the tripod joint embodying the invention is shown in the right half for comparison.

Please amend the paragraph bridging pages 24 and 25 as follows:

The first and second embodiments are the same as far as the basic construction of tripod joint is concerned and as previously described in connection with Figs. 2A, 2B, 3A, 3B, and 3C. Here, the outer peripheral surface of the roller 30 may be a partial spherical surface with its center of curvature located on the axis; besides this, it may be a convexly curved surface using an arc as its generating line with its center of curvature located at a position radially spaced from the axis. The form of contact of the roller 30 with the roller guide surfaces 14 may be angular contact as shown in Fig. 5A or circular contact as shown in Fig. 5B, wherein reference character r identifies the radius of curvature of the outer peripheral surface of the roller 30. Angular contact has a certain contact angle and occurs at two points, so that contact

ellipses occur at two points in the direction of contact angle. Circular contact occurs between spherical surfaces and at one point. In either case, it is necessary to set the width L_s of the roller 30 so that the contact ellipse does not deviate from the end surface of the roller 30 but comes within the roller width when a predetermined torque is applied. If the contact ratio is small, the contact ellipse becomes larger during torque application, exceeding the width L_s of the roller 30, leading to short life. Reversely, if the contact ratio is large, the contact ellipse becomes smaller, but the surface pressure increases, accelerating the wearing of the contact portions, leading to short life. Structurally, however, the surface pressure in the tripod joint is severest in the region between the trunnion journal 22 and the needle rollers 32; therefore, it is recommended to set the contact ratio so that the surface pressure in this region does not exceed the limit. Concretely, the contact ratio should be in the range of 1.02 – 1.2 or more preferably in the range of 1.05 – 1.18. Further, the ratio L_s/d_o of the width L_s to the outer diameter d_o of the roller 30 should be 0.24 – 0.27.

Marked Up Version of Claims as Amended

IN THE CLAIMS:

Please amend claims 1-2, 4 and 6-7 as follows:

1. (Amended) A tripod constant velocity universal joint [including]
comprising:

an outer joint member having three axial track grooves in [the] an inner periphery and roller guide surfaces formed in [the opposed] opposing side walls of each track groove[.];

a tripod member having three radially projecting trunnion journals[.]; and
rollers [rotatable] that rotate around [the] respective trunnion journals through a plurality of needle rollers and received in the track grooves of said outer joint member, each roller being guided [in the] on an outer peripheral surface by said roller guide surfaces,

wherein contact between said roller and said roller guide surfaces is circular contact [whose] having a contact ratio [is] 1.01 or above, [and the] wherein a width dimension of said roller is reduced to [the] an extent that [the] a contact ellipse produced [in] by said roller during [the] application of a predetermined torque does not deviate from [the] an end surface of said roller, and

wherein said contact ratio is defined by a ratio of a radius of curvature of said roller guide surface relative to a radius of curvature of said outer peripheral surface.

2. (Amended) A tripod constant velocity universal joint as set forth in Claim 1, wherein the contact ratio of said roller to said roller guide surface is so set that [the] contact surface pressure produced on said roller during [the] application of [a] the predetermined torque is not more than [the] contact

surface pressure produced between said trunnion journal and said needle rollers.

4. (Amended) A tripod constant velocity universal joint as set forth in Claim 1, wherein [the] a ratio L_s/d_o of the width (L_s) to [the] an outer diameter (d_o) of said roller is 0.32 or below.

6. (Amended) A tripod constant velocity universal joint as set forth in Claim 1, wherein [the] a portion of said roller guide surface corresponding to the end of said roller is formed with a relief portion.

7. (Amended) A tripod constant velocity universal joint as set forth in Claim 6, wherein said relief portion is [in the form of] an arc smoothly connected to said roller guide surface.